T980 STATUS: CHANGES, TESTS AND PLANS FOR 2009-2010

Nikolai Mokhov, Dean Still

Fermilab

LARP CM13 Collaboration Meeting
Port Jefferson, NY
November 4-6, 2009

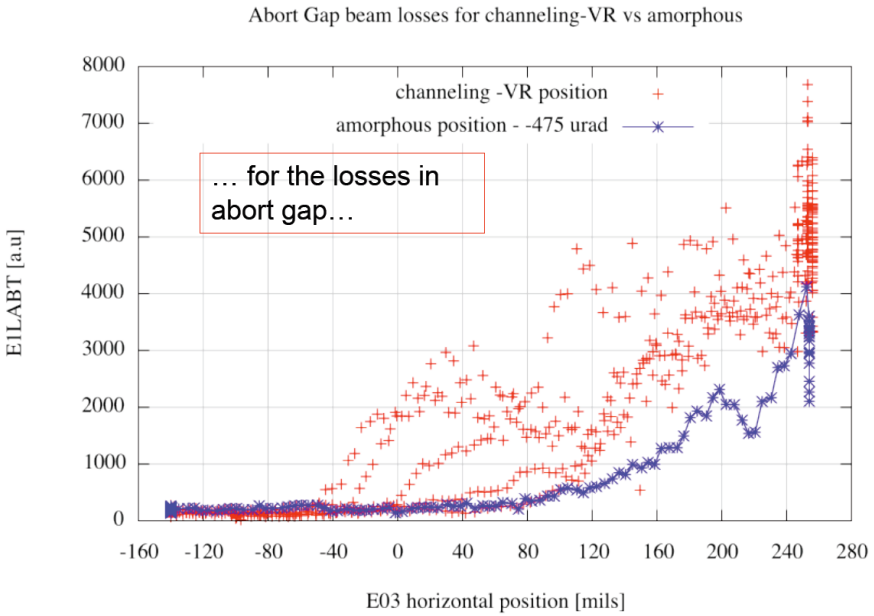
OUTLINE

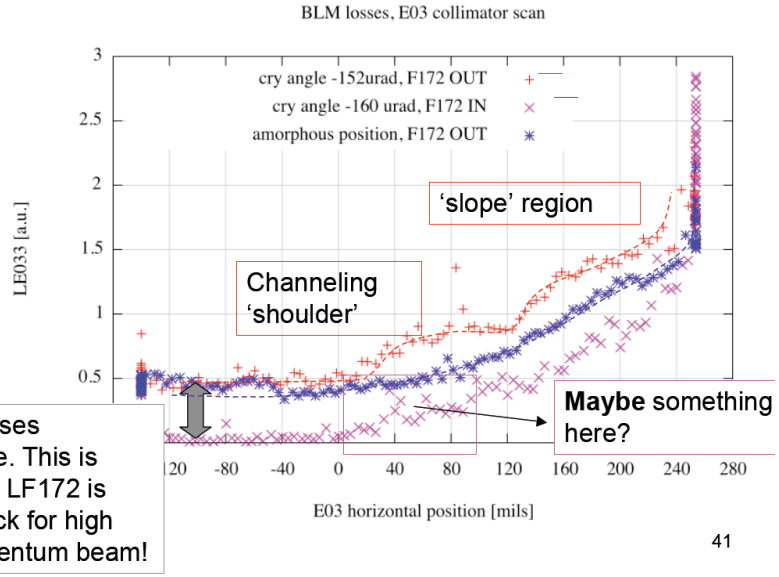
- Beam studies before summer shutdown
- Vertical Goniometer
- New 3-Crystal 2-Goniometer Setup
- Simulations
- First End-of-Store Beam Test
- Plans

Beam Loss Localization vs E03 Position

Original O-shaped xtal (large miscut).
Hor goniometer improved in early 2009.

Channeling improves localization!

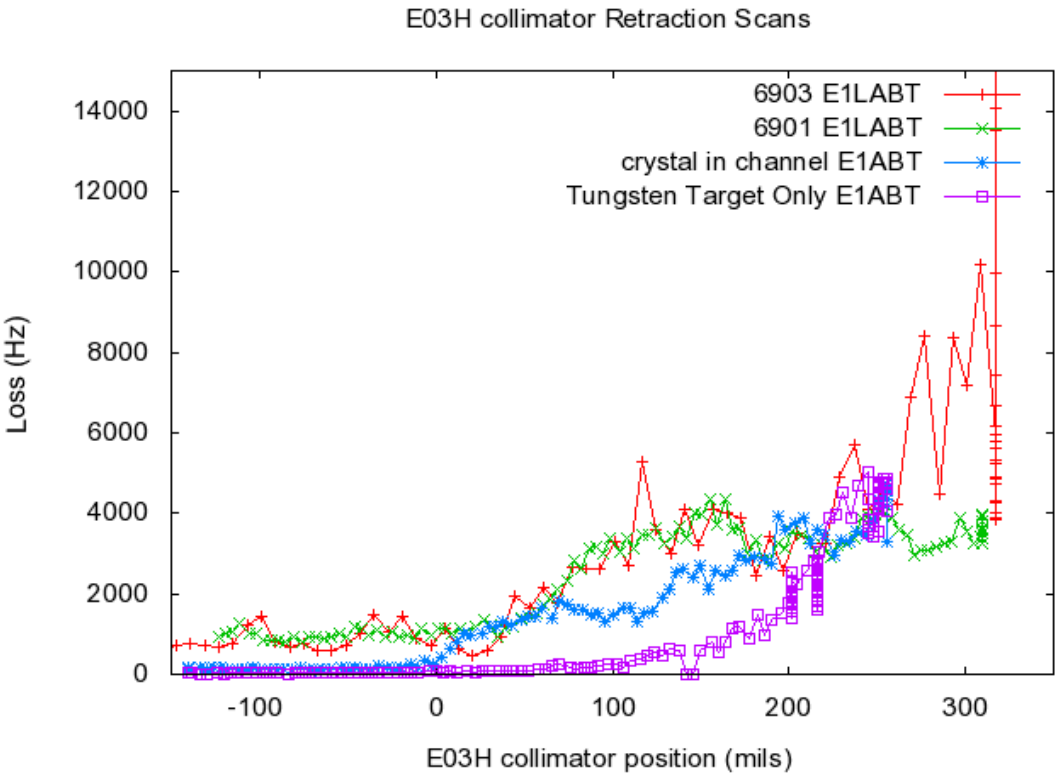




Other collimator positions need to be tuned for the crystal collimation!

Practical aspects of crystal collimation are much more delicate than those of conventional two-stage collimation system!

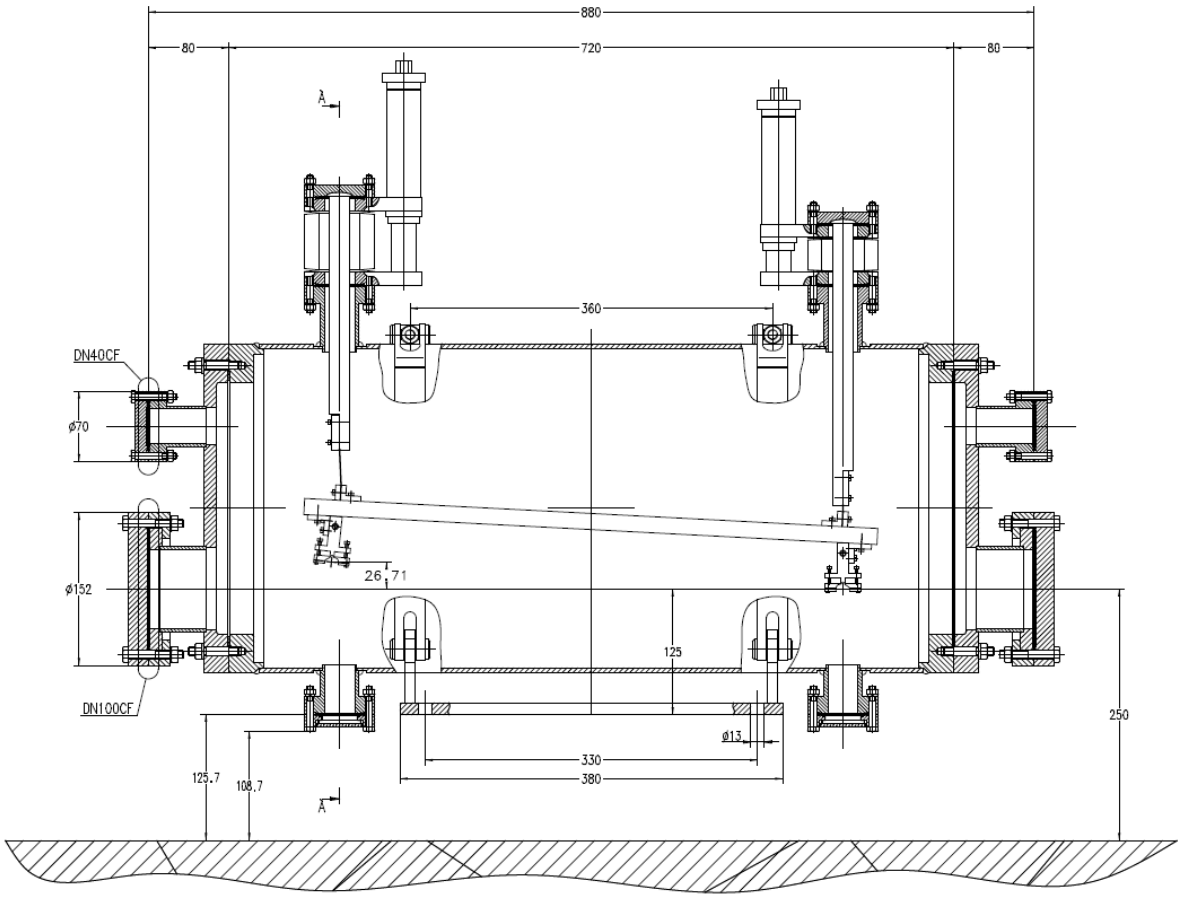
First Use of Crystal for the Entire Collider Store

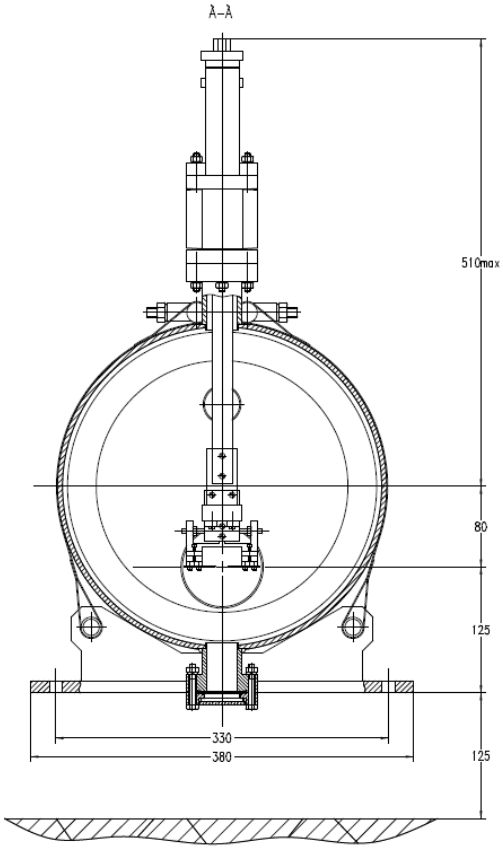


March 17-18, 2009

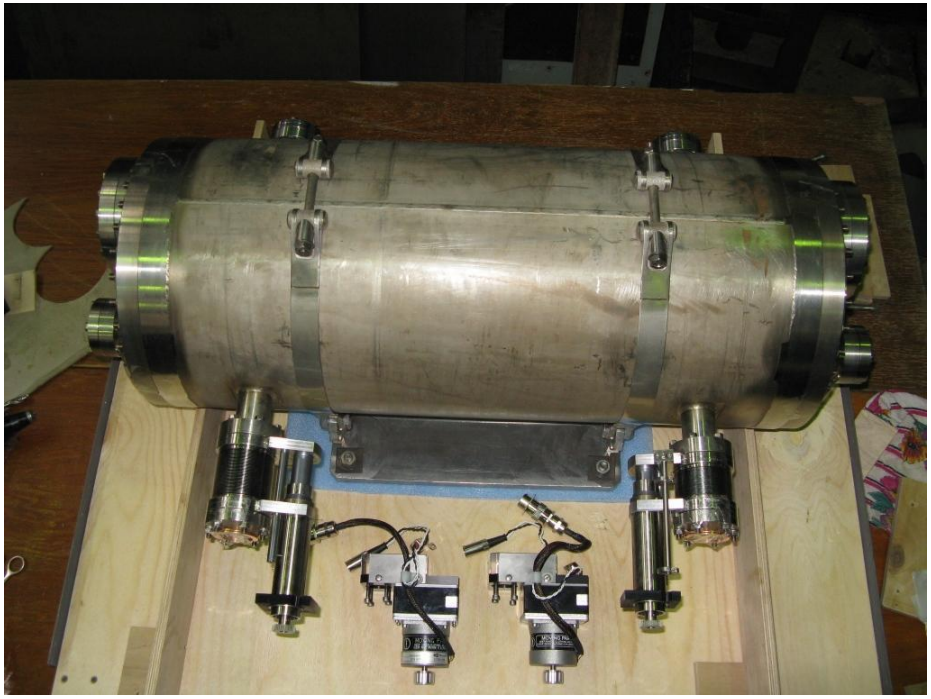
1. Successful test of crystal automatic insertion with no impact on the store.
2. Evidence of better cleaning.
3. Found angular drift over the entire store (heating).

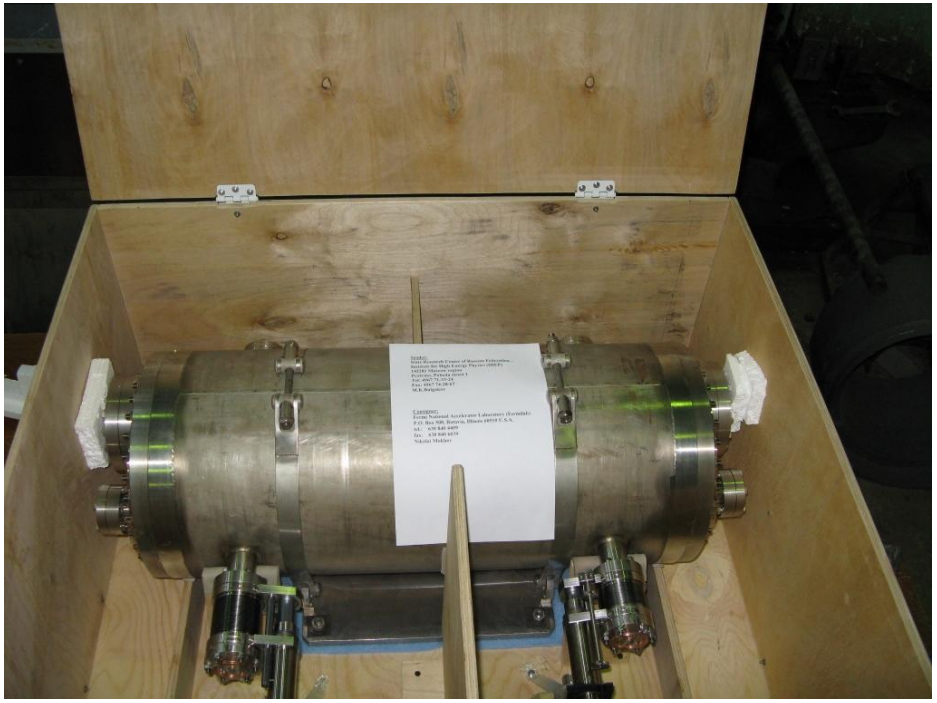
New Two-Crystal Vertical Goniometer by IHEP





Shipping Goniometer from IHEP to Fermilab



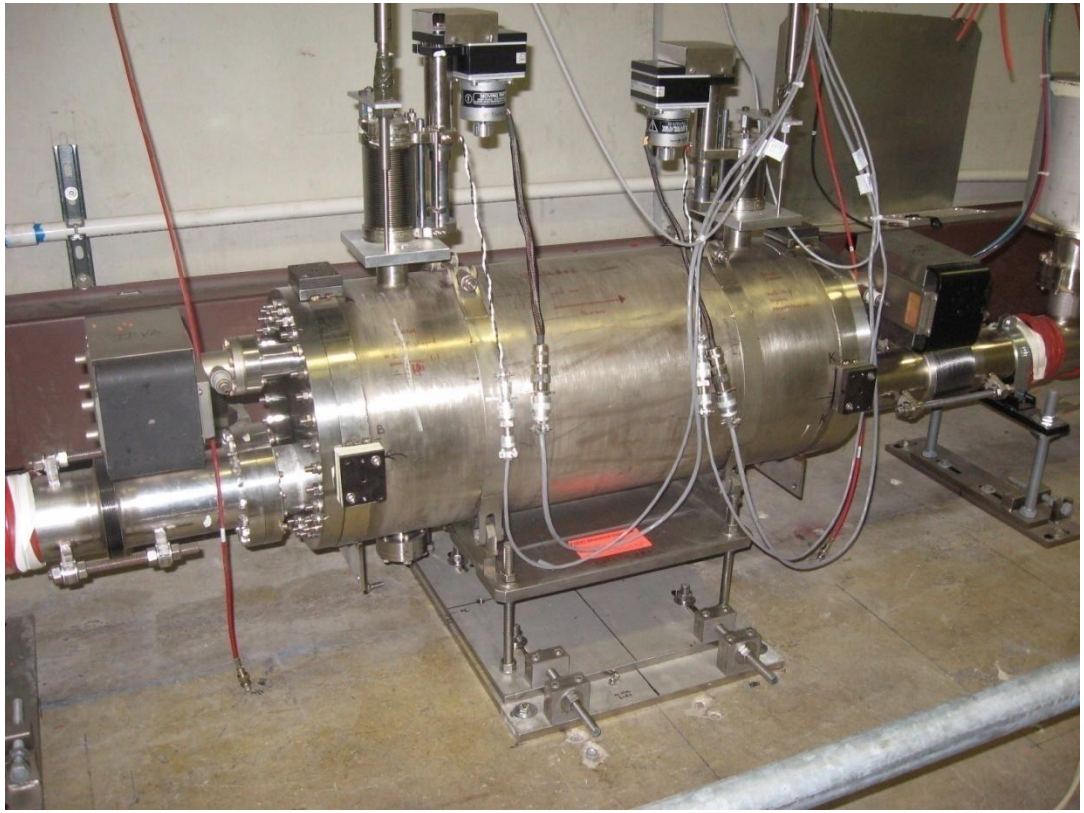


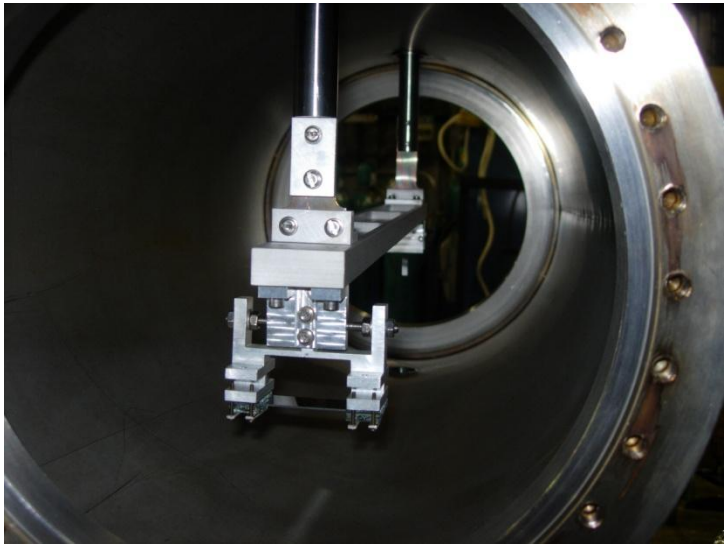
New Vertical Goniometer (1)

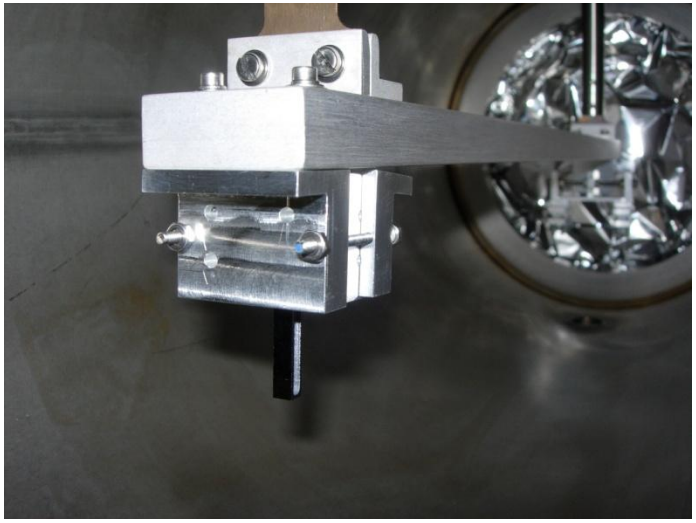
Has been vacuum certified and installed in the tunnel at E0 during the Summer 2009 shutdown. Mechanically it has been checked out and is ready to use.

Having some controls delays as the front-end processor needed significant reprogramming to accept new structures and motor schemes adapted from current collimator controls. These should be ready by mid-November 2009.

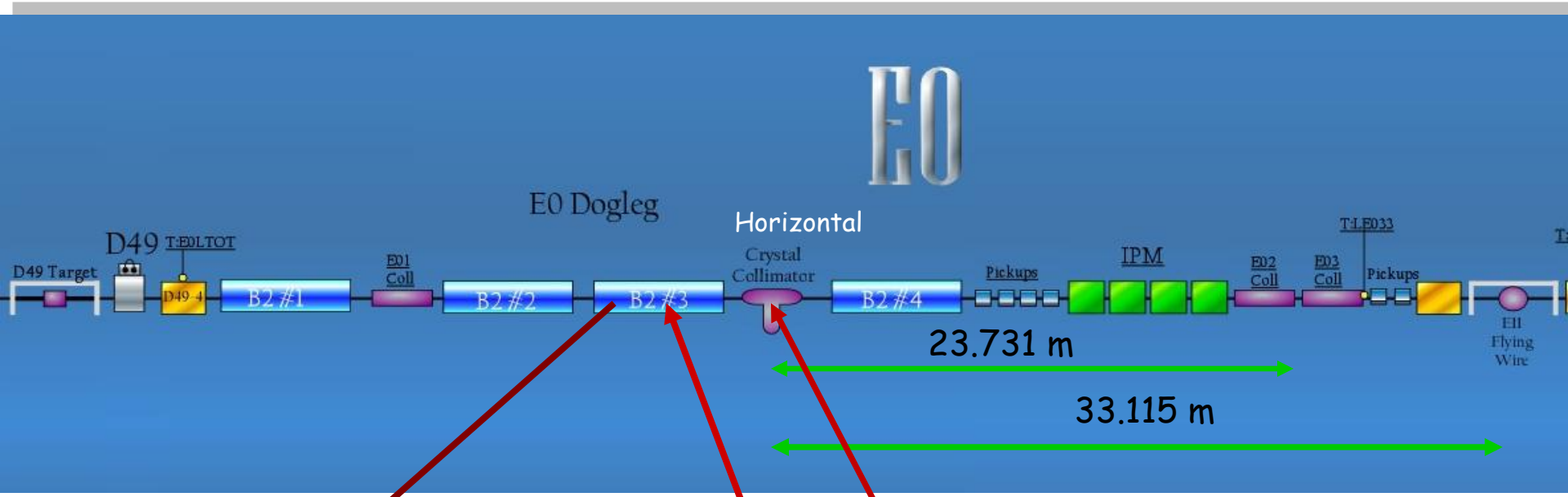
New Vertical Goniometer (2)







T980 Setup in Tevatron E0 for 2009-2010



Replaced old O-shaped xtal with new 0.36mrad O-shaped with negative 0.12mrad miscut

Removed B2-3 dipole

Installed new Vertical 2-xtal goniometer 4 m upstream of the Horizontal gonoimeter

Now able to use 1 or 2 xtals in beam, alternating them without breaking vacuum !

List of Work Accomplished

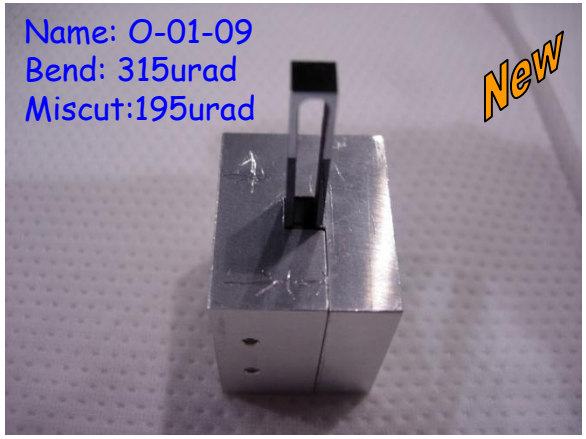
- Received vertical goniometer (VG) from IHEP April 2009.
- Baked and performed initial vacuum leak check.
- Verified all motion and estimated limits.
- Removed B2 magnet from Tevatron tunnel at E0 to make room for VG.
- Built new vacuum spool piece for VG to be installed in place of B2 magnet.
- Received 3 new beam characterized crystals from IHEP June 2009.
- Prepared crystals and installed 2 in VG and 1 in horizontal goniometer (HG).
- Aligned and referenced VG and HG with new crystals installed.
- Baked, leak checked and vacuum certified VG and HG for tunnel installation.
- Installed and aligned VG and HG in Aug 2009.
- Installed new scintillator paddle and electronics at F17 Aug-Oct 2009.
- Working on VG controls Aug-Nov 2009.
- Started beam studies with HG October 30, 2009.

Goniometer Control

Intermittent drive is tested with the power blocks SMD-42 and the control block CMC-3. Feeding voltage was supplied from the power unit B5-47 (24 volts, 3 A). Tests were conducted in two regimes: full-step and with splitting of step to 1/2 and 1/4. As the initial velocity of rotation it was selected zero speed as well as speed equal to nominal. In the full-step regime of optimum proved to be the rotational speed of 100 steps/second. For the regimes with splitting of step, it was increased 2 and 4 times accordingly. In this case, naturally, the number of steps was increased 2 and 4 times for obtaining the necessary displacement.

In the full-step regime, 4200 steps provide 1 millimeter of the linear displacement (0.25 microns per step). The operation crystal position (with the crystal on the beam axis) is equal to 63.5 mm on the rule on the reducer (in this case the second unused crystal has a coordinate 43.5 mm), i.e., it is 20-mm behind the first used one. In this case the first working flat crystal has an angle close to zero. The alignment can be performed according to these crystals. A minor correction will be required for the real bent crystals.

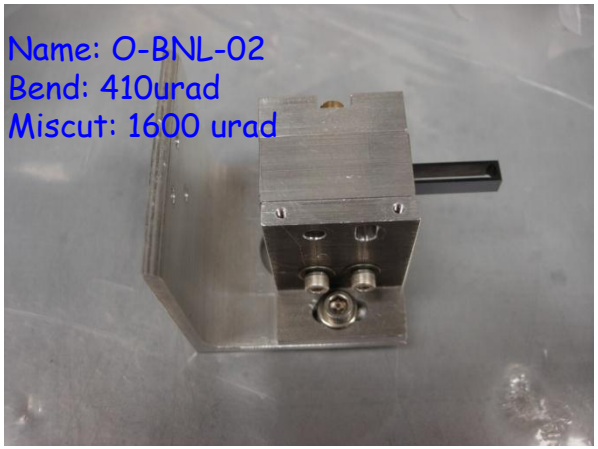
New Crystals



Broken during installation

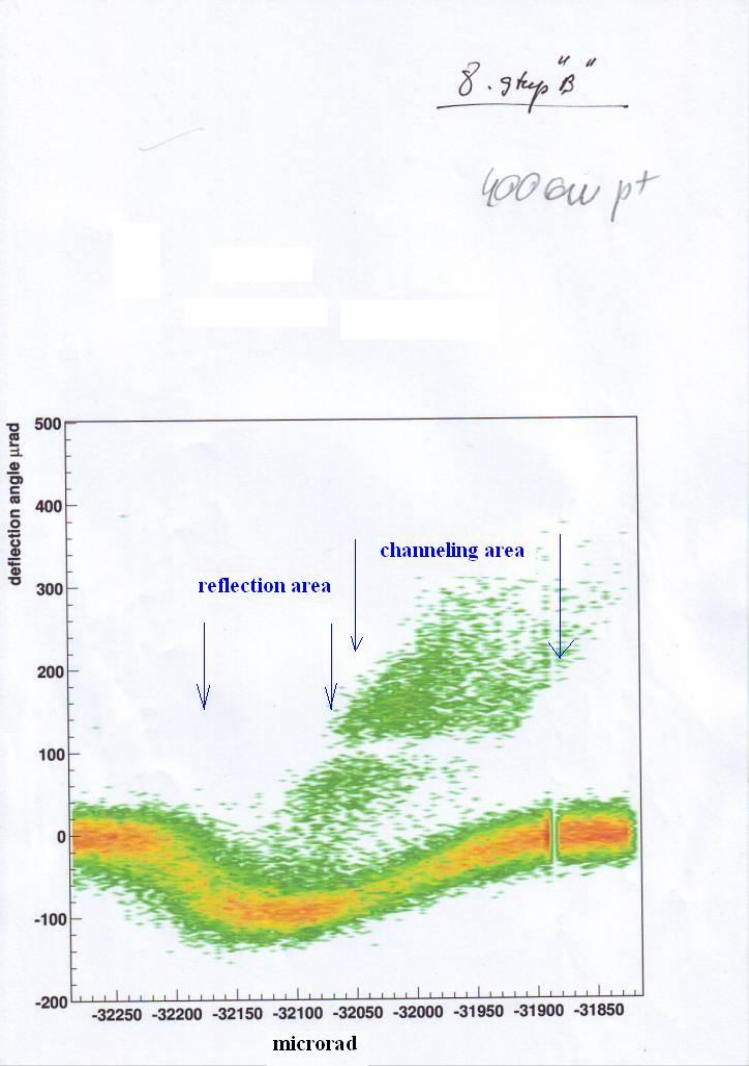
Installed Ver Dnstrm goniometer

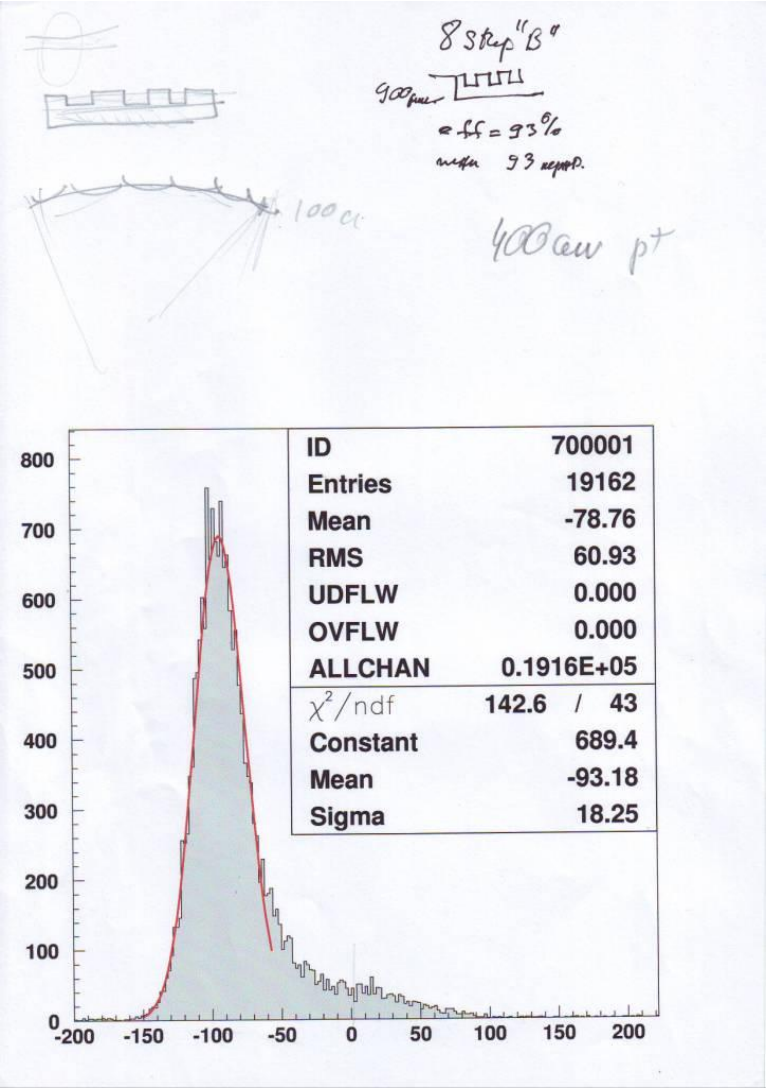
Installed Hor goniometer



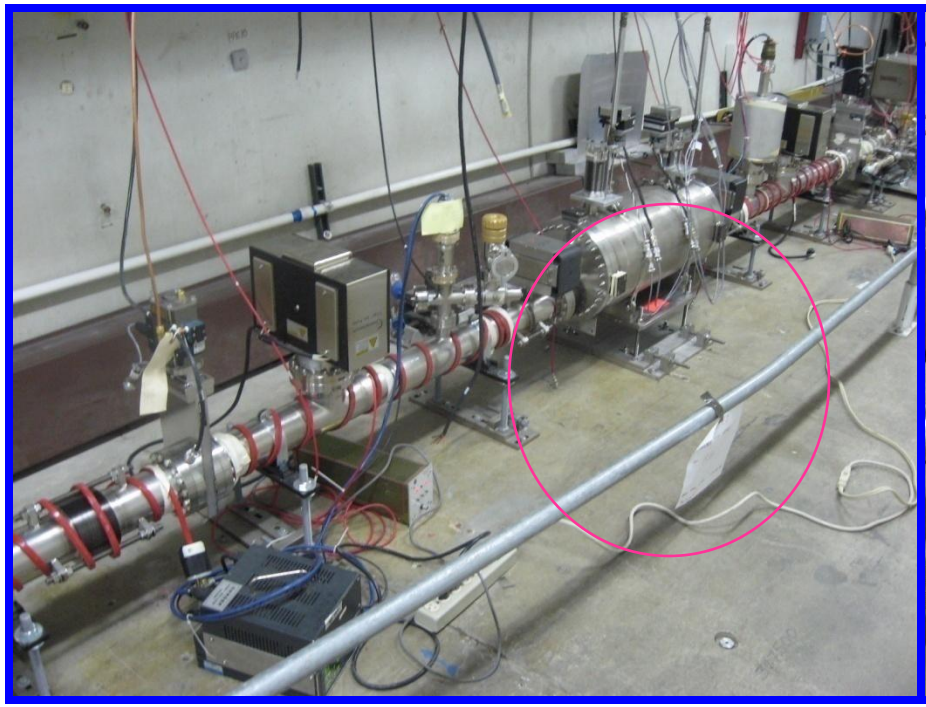
Installed Ver Upstrm goniometer

Testing 8-strip xtal with SPS 400-GeV Beam





Goniometer Installations



Newly built and installed (Summer 2009) vertical goniometer at E0.
It is ~ 4m upstream of the Hor. one.
Ver. goniometer houses old O-shaped crystal (reversed for negative miscut) and multi-strip crystal.

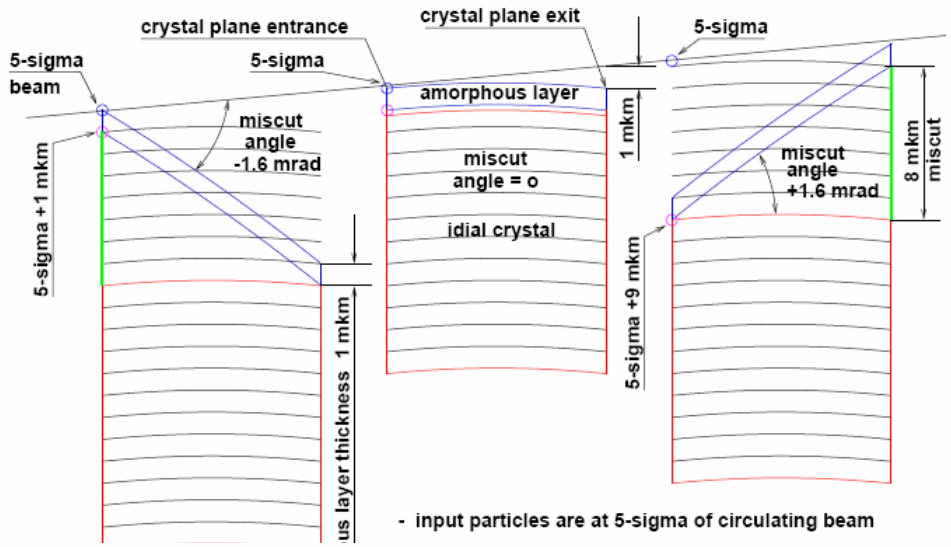
Modified horizontal goniometer.
Replaced old large miscut positive angle O-shaped crystal with new small miscut negative angle O-shaped during Summer 2009.

New Instrumentation at F17

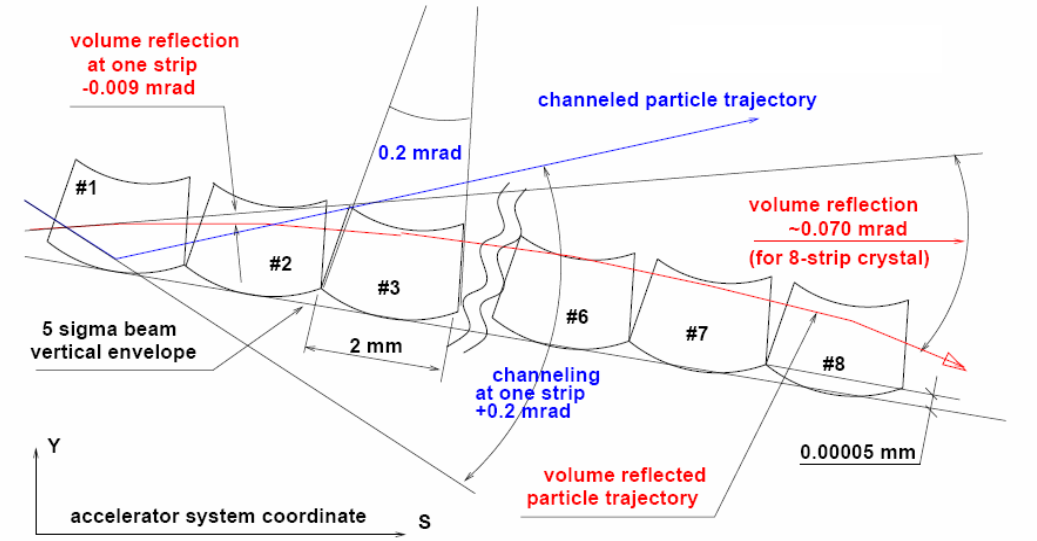
New instrumentation (scintillator paddle and electronics) similar to E0 has been installed at F17 to detect VR beam from multi-strip crystal.

Instrument will have capability to distinguish loss from the bunch and abort gaps.

Computer Modeling for New T980

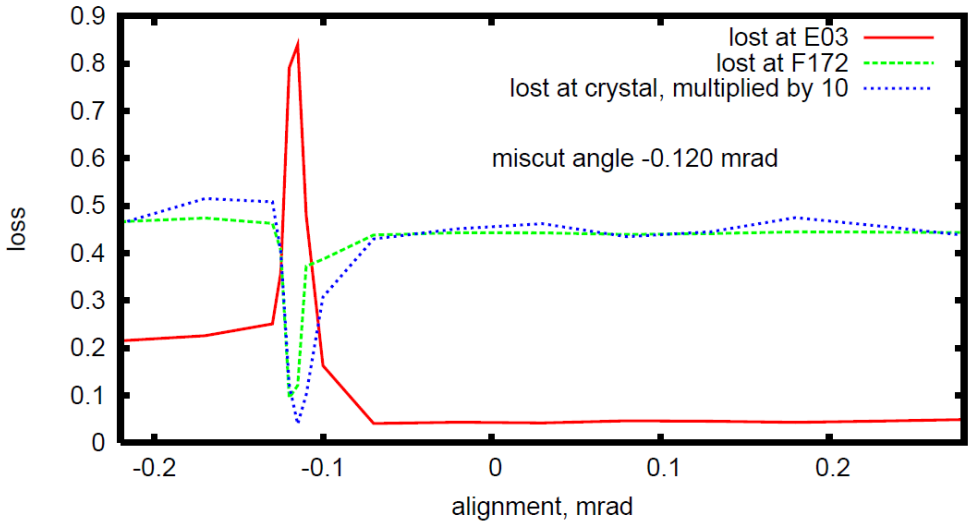


Miscut angle:
make it small (≤ 0.2 mrad)
and negative for partial
or full channeling

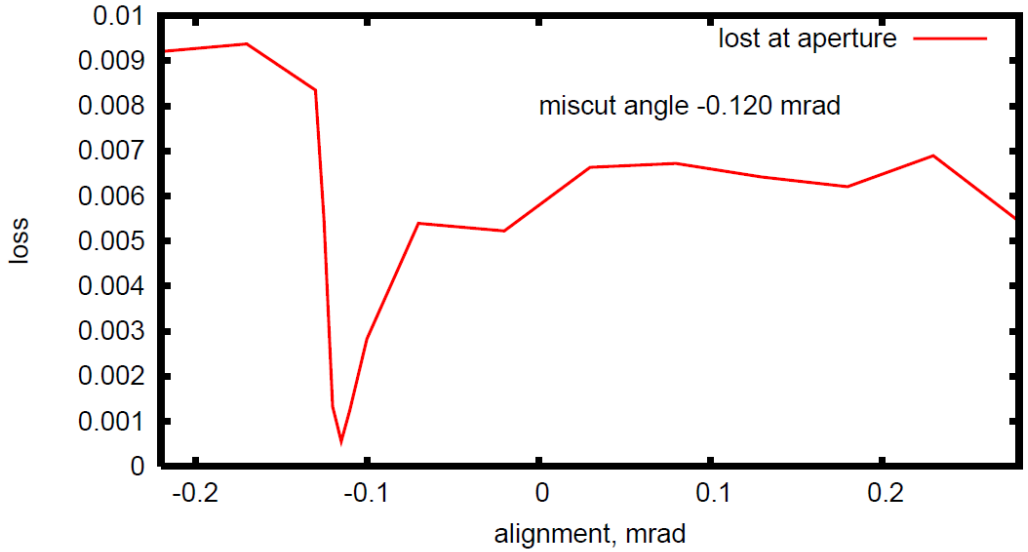


Multistrip crystal:
both volume reflection (F172)
and multi-channeling (E03)
work at Tevatron

STRUCT/CRYAPR Beam Loss: New O-shaped (H)



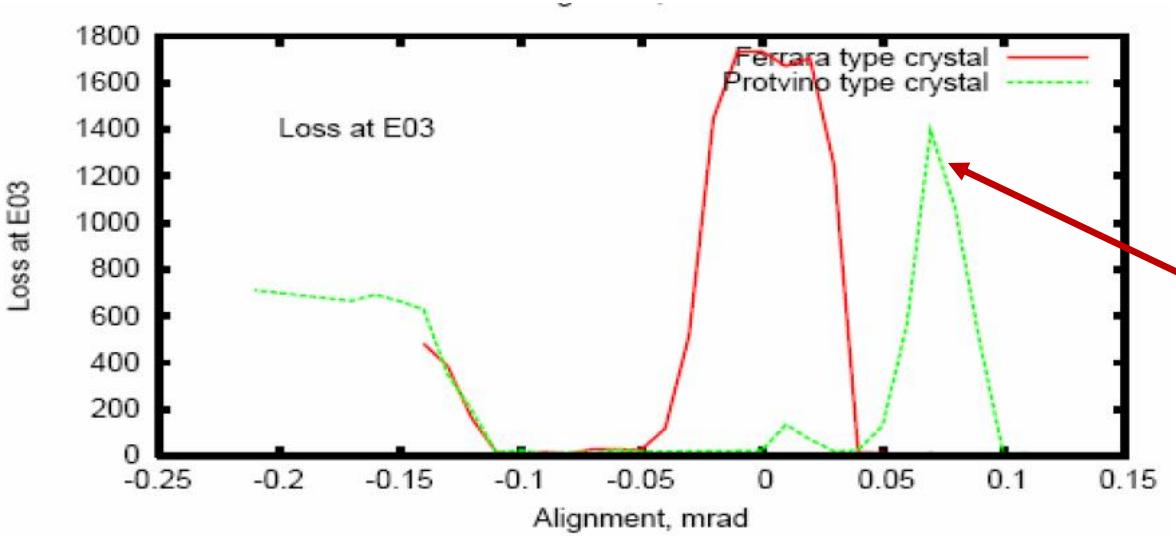
E03 and F172 collimators and xtal



Rest of the Tevatron

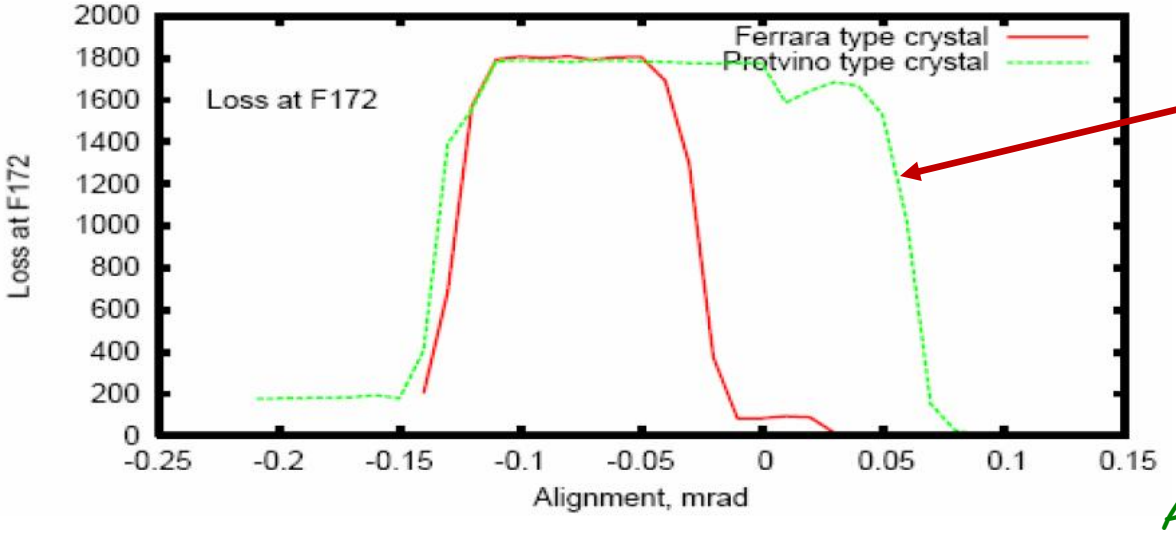
A. Drozhdin

STRUCT/CRYAPR Beam Loss: New Multi-strip (V)



E03 and F172 collimators

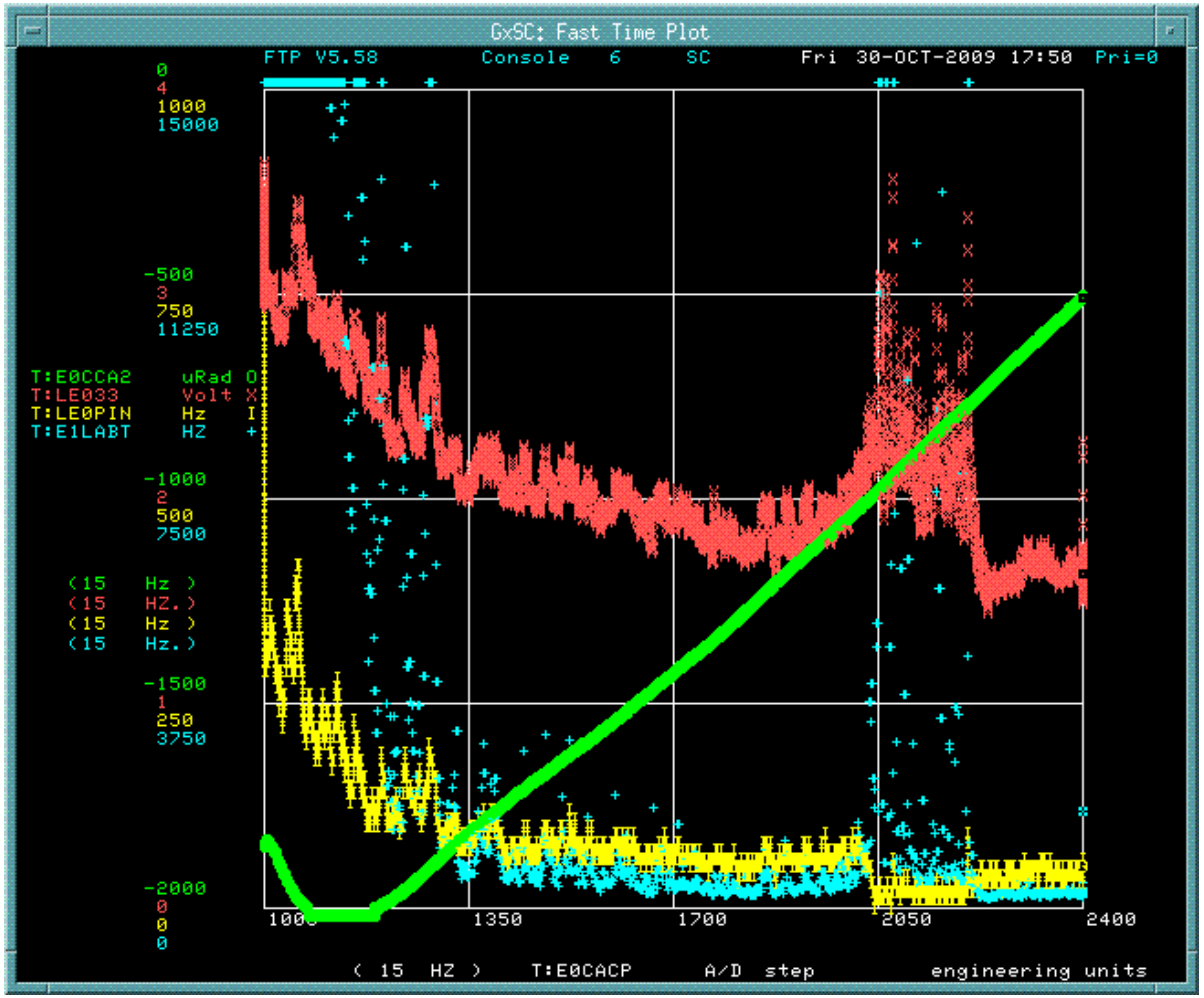
Channeling



Volume Reflection

A. Drozhdin

First 980-GeV Beam Test with New Setup



Oct. 30, 2009

Study was very successful!

We centered crystal and did angle scan and found channel, all within less than 2 hrs. We did a 1-μrad fine scan. We also did a E03H retraction scan to measure displaced channeled beam at E03H.

The new F17 detector is good; will allow to distinguish bunch vs abort.

T980 Beam Objectives for 2009-2010

1. Investigate 2-plane bent crystal collimation for the first time in the TeV collider.
2. Investigate crystal collimation efficiency with a multi-strip crystal utilizing volume reflection and compare it to that with a crystal in a channeling mode and with a default amorphous primary collimator in the TeV collider.
3. Both aiming at improving performance of the LHC collimation system .
4. Compare channeling efficiencies for O-shaped crystals with negative and positive large miscut angles.
5. Compare channeling efficiencies for O-shaped crystals for large and small miscut angles.